Section 8 Sampling and Analysis Plan (SAP)

This section presents the SAP developed for the monitoring to be performed during the operation of the Lincoln County Class IV asbestos landfill in Libby, Montana. The primary purpose of this plan is to summarize the sampling requirements for monitoring ambient air and groundwater.

8.1 Air Monitoring

According to ARM 17.50.511(1)(i), the owner/operator of a landfill unit must ensure no violation of requirements developed under the state implementation plan (SIP), approved or promulgated by the EPA administrator pursuant to Section 110 of the Clean Air Act, as amended. Air monitoring requirements for asbestos projects are also included in ARM 17.74.338, Asbestos Abatement Project Control Measures.

Air monitoring during landfill operations shall be performed by the A&E, who shall supply all required air monitoring stations, sampling equipment, and personnel. Air samples shall be analyzed at the A&E's contracted on-site laboratory. The A&E shall provide the landfill operator with results as they are available.

8.1.1 Ambient Sampling Stations

Past sampling results have indicated that the migration of airborne asbestos fibers has been controlled during landfill operations using water application and other engineering controls.

Based on past results, perimeter air monitoring shall be conducted monthly by the A&E during the months that the landfill is in operation. Ambient air sampling shall be conducted by the A&E in accordance with EPA Standard Operating Procedure (SOP) 2015 (Appendix D). The location of the sample stations were selected as follows:

Table 2
Selecting the Location of the Samples Stations at the Lincoln County Landfill

Sample Station Location	Sample Numbers	Rationale
Upwind/Background	Collect a minimum of two simultaneous upwind/background samples 30° apart from the prevailing wind-lines.	Establish background levels
Downwind	Collect a minimum of 3 sample stations in a 180° arc downwind from the landfill.	*Indicates if asbestos is leaving the site.
Worst Case/Personal Breathing Zone	**Obtain a personal breathing zone sample on an employee working in the exclusion zone.	Verify and continually confirm and document selection of proper levels of worker protection.

* *Special attention will be paid to the downwind sample station locations*

** *This personal breathing zone sample will represent a worst-case ambient fiber concentration at the landfill cell.*

If at any time ambient air sample results indicate elevated levels of asbestos (two [2] or more LA structures per sample as analyzed by TEM method in the on-site laboratory), landfill operations will be halted, work practices assessed, and engineering controls modified as necessary. If this scenario occurs, the landfill operator shall also be responsible for completing a Work Process Review as described in Section 7.6.2 of this document. The landfill operator shall be responsible for implementing any necessary corrective actions in a timely manner.

8.1.2 Personal Breathing Zone (BZ) Air Sampling

An exposure assessment was completed at the initiation of the landfill operation to ascertain expected exposures during tasks required to be performed during regular landfill operations. This assessment was completed to ensure that all planned control systems were appropriate and protective of workers at the site.

Personal BZ air samples shall be collected by the A&E on landfill operator personnel while performing three tasks during landfill operations inside the exclusion zone. These tasks are classified as: laborer, equipment operator, and truck driver.

Representative 8-hour time weighted average (TWA) task-based exposures shall be evaluated based on air samples representing full-shift exposures. The A&E shall collect TWA samples on landfill operator personnel performing each task. The OSHA PEL for 8-hour TWA employee exposure is 0.1 f/cc by phase contrast microscopy (PCM).

Representative 30-minute short-term exposures shall also be evaluated for each task. 30-minute excursions shall be collected by the A&E on landfill operator personnel performing each task during periods that are most likely to produce the greatest exposure. The OSHA 30-minute excursion limit is 1.0 f/cc by PCM.

The A&E shall evaluate all collected BZ air samples to ensure that the required engineering controls and PPE are protective of human health and remain consistent between the landfill operators. Personal BZ air samples shall be collected by the A&E during each day of landfill operations. This evaluation will ensure employee exposures are below the 8-hour TWA PEL and 30-minute excursion limit. If the 8-hour TWA or 30-minute excursion is above 0.1 f/cc or 1.0 f/cc respectively, then the sample will be analyzed by TEM to identify the concentrations of asbestos structures. This will trigger a re-evaluation of the level of respiratory protection, work practices, and engineering controls. Necessary changes in work practices and engineering controls shall be employed by the landfill operator to lower personal exposures below the 8 hour TWA and 30-minute excursion PEL.

If two consecutive landfill dump events have task based occupational air results above the respective OSHA PEL, the landfill operator will be required to complete a Work Process Review as described in Section 7.6.2 of this document.

8.1.3 Air Sample Collection and Analysis

Ambient air samples shall be collected by the A&E using a constant flow or critical orifice controlled sampling pump. Sampling pumps shall be capable of providing the appropriate flow-rate and duration to achieve desired volumes. Personal BZ air samples shall be collected by the A&E using battery operated low volume sampling pumps. The personal air-sampling pump shall be a self-contained unit small enough to be placed on the monitored employee and not interfere with the work performance. The pump must be capable of sampling at the desired flow-rate and duration.

Sampling pumps shall be calibrated by the A&E immediately before and after each sample period. Sampling pumps shall be calibrated with the sampling cassette in-line using a primary calibrator or a rotometer calibrated to a primary calibrator. Rotometer calibration shall be performed quarterly by the A&E during air sampling at the landfill.

Sampling cassettes shall consist of a conductive filter holder consisting of a 25-mm diameter, 3-piece cassette having a 50-mm long electrically conductive extension cowl with a 25-mm cellulose backup pad. The filter membrane shall consist of a mixed-cellulose ester (MCE), 25-mm, plain, white, 0.4 to 1.2-µm pore size filter.

All personal and ambient air samples collected by the A&E shall be analyzed at the mobile laboratory in Libby, Montana. All personal BZ air samples shall be analyzed using PCM in accordance with National Institute of Occupational Safety and Health (NIOSH) Method 7400. The PCM laboratory results shall be used to calculate the OSHA 8-hour TWA and the 30-minute excursion limit.

All ambient air samples and any personal BZ air samples that exceed the OSHA 8-hour TWA or 30-minute excursion limit by PCM analysis shall be analyzed using TEM in accordance with EPA Asbestos Hazard Emergency Response Act (AHERA) analytical methods (Appendix E).

TEM AHERA uses the same sampling procedures and counting rules as NIOSH Method 7400, but has the advantage over PCM of positive identification of asbestos. Raw analytical data is reported in total structures greater than or equal to 0.5 micrometers (µm) in length and separately for fibers greater than 5 µm in length. This method reports analytical results in total asbestos structures per square millimeter (S/mm^2) of the filter. Analysis of ambient air samples collected by the A&E during landfill operations shall be designed to maintain an analytical sensitivity of 0.005 structures per cubic centimeter (S/cc) of air based on the volume and effective filter area.

8.1.4 QC Air Samples

A&E field personnel shall prepare and collect two types of QC samples: lot blanks and field blanks. Samples shall be collected in accordance with the current version of the Quality Assurance Project Plan for the Libby Asbestos Site, with applicable modifications.

Lot Blanks

Lot blanks shall be prepared by submitting 1 unused air cassette per 500 cassettes from the same lot for analyses to ensure the lot has not been contaminated during production or transit. Lot blanks shall be analyzed by both NIOSH 7400 and TEM AHERA before the lot of cassettes is used to collect air samples. The lot blanks sample results shall be reviewed by the air sampling field team leader. If the lot is proven to be contaminated with two or more f/cc by PCM or one or more LA S/mm^2 by TEM

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AHERA, then the lot of cassettes shall be discarded and a new lot of cassettes will be tested.

Field Blanks

Field blanks shall be collected by removing the cap from the sample cassette at the time of sampling for not more than 30 seconds and replacing it. Each A&E field team shall collect one field blank per day of air sampling. The field blank cassettes shall come from the same lot as the cassettes used that day for air sample collection. One field blank per field team shall be analyzed per week. The remainder of the field blanks collected by field teams, but not analyzed, shall be submitted to the analytical laboratories marked for archive. The field blanks shall be analyzed by each of the following methods: NIOSH 7400 for BZ monitoring field blanks and TEM AHERA for stationary air monitoring field blanks. The field blanks sample results shall be reviewed by the air sampling field team leader. If a field blank is contaminated with two or more f/cc by NIOSH 7400, or one or more LA asbestos S/mm^2 by TEM AHERA, then the field team leader shall contact appropriate personnel to determine whether the occurrence displays a trend in contamination or is isolated. The A&E laboratory coordinator shall decide whether analysis of other archived field blanks is necessary. If it is determined that additional archived field blanks require analysis, they shall be retrieved from archive at the analytical laboratory and analyzed. Field blank results shall be evaluated to determine if field blank contamination is a sample collection procedure deficiency. If at any time field blank contamination appears to be a consistent deficiency in sample collection technique, EPA or its contractors may immediately recommend additional formalized sample collection training and/or an increase in the frequency of field blanks submitted for analysis. If this is implemented, direction on required frequency, acceptance criteria, and corrective action shall be provided in the form of an addendum memorandum or modification form to this SAP.

8.1.5 Sample Identification

Each personal air sample and ambient air sample collected by the A&E shall be identified with a unique code. For QC purposes, the code (Index ID) ensures that all samples have a unique identification number assigned to them. The codes have the format: 1R-XXXXX, where:

1R = alpha-numeric number indicating that samples have been collected in accordance with this SAP

XXXXX = unique, 5-digit sequential number

Index IDs shall be controlled (i.e., signed out and tracked) by the A&E's administrative personnel. The A&E field team leader shall obtain pre-printed Index ID labels from administrative staff prior to the commencement of field sampling for use on field documentation and on sample cassettes.

AHERA, then the lot of cassettes shall be discarded and a new lot of cassettes will be tested.

Field Blanks
Field blanks shall be collected by removing the cap from the sample cassette at the time of sampling for not more than 30 seconds and replacing it. Each A&E field team shall collect one field blank per day of air sampling. The field blank cassettes shall come from the same lot as the cassettes used that day for air sample collection. One field blank per field team shall be analyzed per week. The remainder of the field blanks collected by field teams, but not analyzed, shall be submitted to the analytical laboratories marked for archive. The field blanks shall be analyzed by each of the following methods: NIOSH 7400 for BZ monitoring field blanks and TEM AHERA for stationary air monitoring field blanks. The field blanks sample results shall be reviewed by the air sampling field team leader. If a field blank is contaminated with two or more f/cc by NIOSH 7400, or one or more LA asbestos S/mm^2 by TEM AHERA, then the field team leader shall contact appropriate personnel to determine whether the occurrence displays a trend in contamination or is isolated. The A&E laboratory coordinator shall decide whether analysis of other archived field blanks is necessary. If it is determined that additional archived field blanks require analysis, they shall be retrieved from archive at the analytical laboratory and analyzed. Field blank results shall be evaluated to determine if field blank contamination is a sample collection procedure deficiency. If at any time field blank contamination appears to be a consistent deficiency in sample collection technique, EPA or its contractors may immediately recommend additional formalized sample collection training and/or an increase in the frequency of field blanks submitted for analysis. If this is implemented, direction on required frequency, acceptance criteria, and corrective action shall be provided in the form of an addendum memorandum or modification form to this SAP.

8.1.5 Sample Identification

Each personal air, ambient air, or water sample (see Section 8.2 for instructions regarding the collection of groundwater monitoring samples) collected by the A&E shall be identified with a unique code. For QC purposes, the code (Index ID) ensures that all samples have a unique identification number assigned to them. The codes have the format: 2R-XXXXX (for air samples) or 1R-XXXXX (for water samples), where:

> 1R/2R = alpha-numeric number indicating that samples have been collected in accordance with this SAP
>
> XXXXX = unique, 5-digit sequential number

Index IDs shall be controlled (i.e., signed out and tracked) by the A&E's administrative personnel. The A&E field team leader shall obtain pre-printed Index ID labels from administrative staff prior to the commencement of field sampling for use on field documentation and on sample cassettes, bottles, or other containers.

8.1.6 Sample Documentation

Sampling activities shall be documented by the A&E in a field logbook and on field sample data sheets (FSDSs - Appendix F) that will be maintained by the field team according to CDM SOP 4-1, Field Logbook Content, and Control (Appendix G). The field team leader shall be responsible for maintenance and document control of the field logbook.

8.1.7 Sample Custody, Packaging, and Shipping

This section details the sample custody and the classifying, identifying, labeling, packaging, and transportation of ambient and personal air samples collected by the A&E during landfill operations. Sample classification is necessary to ensure the protection of personnel involved in the shipment of samples, and to maintain the integrity of each sample. Personal air samples and ambient air samples collected during this assessment shall be packaged and shipped by the A&E according to CDM's SOP 2-1 Packaging and Shipping of Environmental Samples (Appendix G).

To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, chain-of-custody (COC) records shall be completed by the A&E. The COC record will be maintained as physical evidence of sample custody and control and provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting. COC procedures shall follow the requirements set forth in CDM SOP 1-2 Sample Custody, with approved project specific modifications (Appendix G), and Project-Specific Guidance for eLASTIC eCOC Module (Appendix J).

The following modifications to SOP 1-2 have been reviewed and approved:

> Section 5.2, Sample Labels and Tags - A label will be affixed to each air sampling cassette prior to being shipped to the appropriate laboratory. This number will correspond to the number assigned (2R-XXXXX for air; 1R-XXXXX for water) to that particular sample on the FSDS.
>
> Samples collected during this investigation shall be packaged and shipped according to CDM SOP 2-1 Packaging and Shipping of Environmental Samples (Appendix G).

The approved modifications to SOP 2-1 are as follows:

> Section 1.4, Required Equipment - Vermiculite (or other absorbent material), bubble wrap, or ice will not be used for packaging or shipping samples.
>
> Section 1.5, Procedures - No vermiculite or other absorbent material will be used to pack the samples. No ice will be used for preserving air samples.

8.1.8 Sample Equipment Decontamination

This project requires the decontamination of all personal air and ambient air sampling equipment (e.g., pumps, cassettes, tubing, etc) by the A&E prior to sampling and prior

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The following modifications to SOP 1-2 have been reviewed and approved:

> Section 5.2, Sample Labels and Tags - A label will be affixed to each air sampling cassette prior to being shipped to the appropriate laboratory. This number will correspond to the number assigned (1R-XXXXX) to that particular sample on the FSDS.
>
> Samples collected during this investigation shall be packaged and shipped according to CDM SOP 2-1 Packaging and Shipping of Environmental Samples (Appendix G).

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>
> Section 1.5, Procedures - No vermiculite or other absorbent material will be used to pack the samples. No ice will be used for preserving air samples.

8.1.8 Sample Equipment Decontamination

This project requires the decontamination of all personal air and ambient air sampling equipment (e.g., pumps, cassettes, tubing, etc) by the A&E prior to sampling and prior to leaving the site. All equipment used to collect, handle, or calibrate samples shall be decontaminated by the A&E.

The decontamination procedure for nondisposable equipment shall consist of wet wiping the exposed surfaces. All equipment shall then be allowed to air-dry. All equipment shall be decontaminated by the A&E before coming into contact with any sample.

8.2 Groundwater Monitoring

8.2.1 Field Investigation

One monitoring well was installed upgradient (CDM-MW-7) and one monitoring well was installed downgradient (CDM-MW-8) of the Class IV asbestos landfill. The locations of the monitoring wells are shown on Figure 4 (Appendix A). Monitoring well construction diagrams are included in the Geotechnical Memorandum (Appendix C).

The monitoring wells were advanced to 259 feet below ground surface (bgs) and 239 feet bgs, respectively. Previous investigative reports indicate that the regional aquifer is located a depth greater than 300 feet bgs while a perched aquifer was identified in the vicinity of the landfill at a depth of 150 to 200 feet bgs. Monitoring wells CDM-MW-7 and CMD-MW-8 were installed within the perched aquifer.

8.2.2 Groundwater Sampling

Monitoring wells CDM-MW-7 and CDM-MW-8 were sampled on July 30 and July 31, 2002 and analyzed for volatile organic compounds (VOCs), total petroleum hydrocarbons (diesel range organics and gasoline range organics), PCBs, priority pollutant 13 metals (PP13 metals), and polynuclear aromatic hydrocarbons (PAHs) by EnChem in Madison, Wisconsin, and asbestos by EMSL in Libby, Montana. Prior to sampling, these newly installed monitoring wells were developed by bailing and pumping using a pumping truck equipped with a stainless steel submersible pump and bailer. Each well was purged for several hours until the turbidity was decreased and the purge water was visually clear. The tubing was decontaminated by running the exterior through a box steam cleaner. Alconox and water were pumped to decontaminate the interior of the hosing and the pump. Baseline sampling data for monitoring wells CDM-MW-7 and CDM-MW-8 is included as Appendix H. Each sample was assigned a unique sample identification number when submitted to the laboratory. The sample description (monitoring well ID) and corresponding sample ID numbers for the July 2002 sampling event are listed below:

Sample ID	Sample Description
1R-14261	MW-8 groundwater sample
1R-14262	MW-8 duplicate groundwater sample
1R-14263	MW-7 groundwater sample

Monitoring wells CDM-MW-7 and CDM-MW-8 were also sampled in May of 2003, prior to commencement of ACM disposal in landfill Cell A. The May 2003 sampling

Appendix D

EPA SOP 2015 Asbestos Sampling

ASBESTOS SAMPLING

1.0 SCOPE AND APPLICATION

Asbestos has been used in many commercial products including building materials such as flooring tiles and sheet goods, paints and coatings, insulation, and roofing asphalts. These products and others may be found at hazardous waste sites hanging on overhead pipes, contained in drums, abandoned in piles, or as part of a structure. Asbestos tailing piles from mining operations can also be a source of ambient asbestos fibers. Asbestos is a known carcinogen and requires air sampling to assess airborne exposure to human health. This Standard Operating Procedure (SOP) provides procedures for asbestos air sampling by drawing a known volume of air through a mixed cellulose ester (MCE) filter. The filter is then sent to a laboratory for analysis. The U.S. Environmental Protection Agency/Environmental Response Team (U.S. EPA/ERT) uses one of four analytical methods for determining asbestos in air. These include: U.S. EPA's Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air for Transmission Electron Microscopy (TEM)[1]; U.S. EPA's Modified Yamate Method for TEM[2]; National Institute for Occupational Safety and Health (NIOSH) Method 7402 (direct method only) for TEM; and NIOSH Method 7400 for Phase Contrast Microscopy (PCM)[3]. Each method has specific sampling and analytical requirements (i.e., sample volume and flow rate) for determining asbestos in air.

The U.S. EPA/ERT typically follows procedures outlined in the TEM methods for determining mineralogical types of asbestos in air and for distinguishing asbestos from non-asbestos minerals. The Phase Contrast Microscopy (PCM) method is used by U.S. EPA/ERT as a screening tool since it is less costly than TEM. PCM cannot distinguish asbestos from non-asbestos fibers, therefore the TEM method may be necessary to confirm analytical results. For example, if an action level for the presence of fibers has been set and PCM analysis indicates that the action level has been exceeded, then TEM analysis can be used to quantify and identify asbestos structures through examination of their morphology crystal structures (through electron diffraction), and elemental composition (through energy dispersive X-ray analysis). In this instance samples should be collected for both analyses in side by side sampling trains (some laboratories are able to perform PCM and TEM analysis from the same filter). The Superfund method is designed specifically to provide results suitable for supporting risk assessments at Superfund sites, it is applicable to a wide range of ambient air situations at hazardous waste sites. U.S. EPA's Modified Yamate Method for TEM is also used for ambient air sampling due to high volume requirements. The PCM and TEM NIOSH analytical methods require lower sample volumes and are typically used indoors; however, ERT will increase the volume requirement for outdoor application.

Other Regulations pertaining to asbestos have been promulgated by U.S. EPA and OSHA. U.S. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) regulates asbestos-containing waste materials. NESHAP establishes management practices and standards for the handling of asbestos and emissions from waste disposal operations (40 CFR Part 61, Subparts A and M). U.S. EPA's 40 CFR 763 (July 1, 1987)[4] and its addendum 40 CFR 763 (October 30, 1987)[4] provide comprehensive rules for the asbestos abatement industry. State and local regulations on these issues vary and may be more stringent than federal requirements. The OSHA regulations in 29 CFR 1910.1001 and 29 CFR 1926.58 specify work practices and safety equipment such as respiratory protection and protective clothing when handling asbestos. The OSHA standard for an 8-hour, time-weighted average (TWA) is 0.2 fibers/cubic centimeters of air. This standard pertains to fibers with a length-to-width ratio of 3 to 1 with a fiber length >5 µm[5,6]. An action level of 0.1 fiber/cc (one-half the OSHA standard) is the level U.S. EPA has established in which employers must initiate such activities as air monitoring, employee training, and medical surveillance[5,6].

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Prior to sampling, the site should be characterized by identifying on-site as well as off-site sources of airborne asbestos. The array of sampling locations and the schedule for sample collection, is critical to the success of an investigation. Generally, sampling strategies to characterize a single point source are fairly straightforward, while multiple point sources and area sources increase the complexity of the sampling strategy. It is not within the scope of this SOP to provide a generic asbestos air sampling plan. Experience, objectives, and site characteristics will dictate the sampling strategy.

During a site investigation, sampling stations should be arranged to distinguish spatial trends in airborne asbestos concentrations. Sampling schedules should be fashioned to establish temporal trends. The sampling strategy typically requires that the concentration of asbestos at the source (worst case) or area of concern (downwind), crosswind, as well as background (upwind) contributions be quantified. See Table 1 (Appendix A) for U.S. EPA/ERT recommended sampling set up for ambient air. Indoor asbestos sampling requires a different type of strategy which is identified in Table 2 (Appendix A). It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks can be utilized to determine other sources.

Much information can be derived from each analytical method previously mentioned. Each analytical method has specific sampling requirements and produce results which may or may not be applicable to a specific sampling effort. The site sampling objectives should be carefully identified so as to select the most appropriate analytical method. Additionally, some preparation (i.e., lot blanks results) prior to site sampling may be required, these requirements are specified in the analytical methods.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Sample Preservation

No preservation is required for asbestos samples.

3.2 Sample Handling, Container and Storage Procedures

1. Place a sample label on the cassette indicating a unique sampling number. Do not put sampling cassettes in shirt or coat pockets as the filter can pick up fibers. The original cassette box is used to hold the samples.

2. Wrap the cassette individually in a plastic sample bag. Each bag should be marked indicating sample identification number, total volume, and date.

3. The wrapped sampling cassettes should be placed upright in a rigid container so that the cassette cap is on top and cassette base is on bottom. Use enough packing material to prevent jostling or damage. Do not use vermiculite as packing material for samples. If possible, hand carry to lab.

4. Provide appropriate documentation with samples (i.e., chain of custody and requested analytical methodology).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Flow rates exceeding 16 liters/minute (L/min) which could result in filter destruction due to (a) failure of its physical support under force from the increased pressure drop; (b) leakage of air around the filter mount so that the filter is bypassed, or (c) damage to the asbestos structures due to increased impact velocities.

4.1 U.S. EPA's Superfund Method

4.1.1 Direct-transfer TEM Specimen Preparation Methods

Direct-Transfer TEM specimen preparation methods have the following significant interferences:

- C The achievable detection limit is restricted by the particulate density on the filter, which in turn is controlled by the sampled air volume and the total suspended particulate concentration in the atmosphere being sampled.

- C The precision of the result is dependent on the uniformity of the deposit of asbestos structures on the sample collection filter.

- C Air samples must be collected so that they have particulate and fiber loadings within narrow ranges. If too high a particulate loading occurs on the filter, it is not possible to prepare satisfactory TEM specimens by a direct-transfer method. If too high a fiber loading occurs on the filter, even if satisfactory TEM specimens can be prepared, accurate fiber counting will not be possible.

4.1.2 Indirect TEM Specimen Preparation Methods

Indirect TEM specimen preparation methods have the following interferences:

- C The size distribution of asbestos structures is modified.

- C There is increased opportunity for fiber loss or introduction of extraneous contamination.

- C When sample collection filters are ashed, any fiber contamination in the filter medium is concentrated on the TEM specimen grid.

It can be argued that direct methods yield an under-estimate of the asbestos structure concentration because many of the asbestos fibers present are concealed by other particulate material with which they are associated. Conversely, indirect methods can be considered to yield an over-estimate because some types of complex asbestos structures disintegrate during the preparation, resulting in an increase in the numbers of structures counted.

4.2 U.S. EPA's Modified Yamate Method for TEM

High concentrations of background dust interfere with fiber identification.

4.3 NIOSH Method for TEM

Other amphibole particles that have aspect ratios greater than 3:1 and elemental compositions similar to the asbestos minerals may interfere in the TEM analysis. Some non-amphibole minerals may give electron diffraction patterns similar to amphiboles. High concentrations of background dust interfere with fiber identification.

4.4 NIOSH Method for PCM

PCM cannot distinguish asbestos from non-asbestos fibers; therefore, all particles meeting the counting criteria are counted as total asbestos fibers. Fiber less than 0.25 um in length will not be detected by this method. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

5.0 EQUIPMENT/MATERIALS

5.1 Sampling Pump

The constant flow or critical orifice controlled sampling pump should be capable of a flow-rate and pumping time sufficient to achieve the desired volume of air sampled.

The lower flow personal sampling pumps generally provide a flow rate of 20 cubic centimeters/minute (cc/min) to 4 L/min. These pumps are usually battery powered. High flow pumps are utilized when flow rates between 2 L/min to 20 L/min are required. High flow pumps are used for short sampling periods so as to obtain the desired sample volume. High flow pumps usually run on AC power and can be plugged into a nearby outlet. If an outlet is not available then a generator should be obtained. The generator should be positioned downwind from the sampling pump. Additional voltage may be required if more than one pump is plugged into the same generator. Several electrical extension cords may be required if sampling locations are remote.

The recommended volume for the Superfund method (Phase I) requires approximately 20 hours to collect. Such pumps typically draw 6 amps at full power so that 2 lead/acid batteries should provide sufficient power to collect a full sample. The use of line voltage, where available, eliminates the difficulties associated with transporting stored electrical energy.

A stand should be used to hold the filter cassette at the desired height for sampling and the filter cassette shall be isolated from the vibrations of the pump.

5.2 Filter Cassette

The cassettes are purchased with the required filters in position, or can be assembled in a laminar flow hood or clean area. When the filters are in position, a shrink cellulose band or adhesive tape should be applied to cassette joints to prevent air leakage.

5.2.1 TEM Cassette Requirements

Commercially available field monitors, comprising 25 mm diameter three-piece cassettes, with conductive extension cowls shall be used for sample collection. The cassette must be new and not previously used. The cassette shall be loaded with an MCE filter of pore size 0.45 µm, and supplied from a lot number which has been qualified as low background for asbestos determination. The cowls should be constructed of electrically conducting material to minimize electrostatic effects. The filter shall be backed by a 5 µm pore size MCE filter (Figure 1, Appendix B).

5.2.2 PCM Cassette Requirements

NIOSH Method 7400, PCM involves using a 0.8 to 1.2 µm mixed cellulose ester membrane, 25 mm diameter, 50 mm conductive cowl on cassette (Figure 2, Appendix B). Some labs are able to perform PCM and TEM analysis on the same filter; however, this should be discussed with the laboratory prior to sampling.

5.3 Other Equipment

- Inert tubing with glass cyclone and hose barb
- Whirlbags (plastic bags) for cassettes
- Tools - small screw drivers
- Container - to keep samples upright
- Generator or electrical outlet (may not be required)
- Extension cords (may not be required)
- Multiple plug outlet
- Sample labels
- Air data sheets
- Chain of Custody records

6.0 REAGENTS

Reagents are not required for the preservation of asbestos samples.

7.0 PROCEDURES

7.1 Air Volumes and Flow Rates

Sampling volumes are determined on the basis of how many fibers need to be collected for reliable measurements. Therefore, one must estimate how many airborne fibers may be in the sampling location.

Since the concentration of airborne aerosol contaminants will have some effect on the sample, the following is a suggested criteria to assist in selecting a flow rate based on real-time aerosol monitor (RAM) readings in milligrams/cubic meter (mg/m³).

	Concentration	Flow Rate
Low RAM readings:	<6.0 mg/m³	11-15. L/min
Medium RAM readings:	>6.0 mg/m³	7.5 L/min
High RAM readings:	>10. mg/m³	2.5 L/min

In practice, pumps that are available for environmental sampling at remote locations operate under a maximum load of approximately 12 L/min.

7.1.1 U.S. EPA's Superfund Method

The Superfund Method incorporates an indirect preparation procedure to provide flexibility in the amount of deposit that be can be tolerated on the sample filter and to allow for the selective concentration of asbestos prior to analysis. To minimize contributions to background contamination from asbestos present in the plastic matrices of membrane filters while allowing for sufficient quantities of asbestos to be collected, this method also requires the collection of a larger volume of air per unit area of filter than has traditionally been collected for asbestos analysis. Due to the need to collect large volumes of air, higher sampling flow rates are recommended in this method than have generally been employed for asbestos sampling in the past. As an alternative, samples may be collected over longer time intervals. However, this restricts the flexibility required to allow samples to be collected while uniform meteorological conditions prevail.

The sampling rate and the period of sampling should be selected to yield as high a sampled volume as possible, which will minimize the influence of filter contamination. Wherever possible, a volume of 15 cubic meters (15,000 L) shall be sampled for those samples intended for analysis only by the indirect TEM preparation method (Phase 1 samples). For those samples to be prepared by both the indirect and the direct specimen preparation methods (Phase 2 samples), the volumes must be adjusted so as to provide a suitably-loaded filter for the direct TEM preparation method. One option is to collect filters at several loadings to bracket the estimated optimum loading for a particular site. Such filters can be screened in the laboratory so that only those filters closest to optimal loading are analyzed. It has been found that the volume cannot normally exceed 5 cubic meters (5000 L) in an urban or agricultural area, and 10 cubic meters (10,000 L) in a rural area for samples collected on a 25 mm filter and prepared by a direct-transfer technique.

An upper limit to the range of acceptable flow rates for this method is 15 L/min. At many locations, wind patterns exhibit strong diurnal variations. Therefore, intermittent sampling (sampling over a fixed time interval repeated over several days) may be necessary to accumulate 20 hours of sampling time over constant wind conditions. Other sampling objectives also may necessitate intermittent sampling. The objective is to design a sampling schedule so that samples are collected under uniform conditions throughout the sampling interval. This method provides for such options. Air volumes collected on Phase I samples are maximized (<16 L/min). Air volumes collected on Phase 2 samples are limited to provide optimum loading for filters to be prepared by a direct-transfer procedure.

7.1.2 U.S. EPA's Modified Yamate Method for TEM

U.S. EPA's TEM method requires a minimum volume of 560 L and a maximum volume of 3,800 L in order to obtain an analytical sensitivity of 0.005 structures/cc. The optimal volume for TEM is 1200 L to 1800 L. These volumes are determined using a 200 mesh EM grid opening with a 25-mm filter cassette. Changes in volume would be necessary if a 37-mm filter cassette is used since the effective area of a 25 mm (385 sq mm) and 37 mm (855 sq m) differ.

7.1.3 NIOSH Method for TEM and PCM

The minimum recommended volume for TEM and PCM is 400 L at 0.1 fiber/cc. Sampling time is adjusted to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for eight hours (700 to 2800 L) is appropriate in non-dusty atmospheres containing 0.1 fiber/cc. Dusty atmospheres i.e., areas with high levels of asbestos, require smaller sample volumes (<400 L) to obtain countable samples.

In such cases, take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3,000 to 10,000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If > 50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration. Do not exceed 0.5 mg total dust loading on the filter.

7.2 Calibration Procedures

In order to determine if a sampling pump is measuring the flow rate or volume of air correctly, it is necessary to calibrate the instrument. Sampling pumps should be calibrated immediately before and after each use. Preliminary calibration should be conducted using a primary calibrator such as a soap bubble type calibrator, (e.g., a Buck Calibrator, Gilibrator, or equivalent primary calibrator) with a representative filter cassette installed between the pump and the calibrator. The representative sampling cassette can be reused for calibrating other pumps that will be used for asbestos sampling. The same cassette lot used for sampling should also be used for the calibration. A sticker should be affixed to the outside of the extension cowl marked "Calibration Cassette."

A rotameter can be used provided it has been recently precalibrated with a primary calibrator. Three separate constant flow calibration readings should be obtained both before sampling and after sampling. Should the flow rate change by more than 5% during the sampling period, the average of the pre- and post-calibration rates will be used to calculate the total sample volume. The sampling pump used shall provide a non-fluctuating air-flow through the filter, and shall maintain the initial volume flow-rate to within ± 10% throughout the sampling period. The mean value of these flow-rate measurements shall be used to calculate the total air volume sampled. A constant flow or critical orifice controlled pump meets these requirements. If at any time the measurement indicates that the flow-rate has decreased by more than 30%, the sampling shall be terminated. Flexible tubing is used to connect the filter cassette to the sampling pump.Sampling pumps can be calibrated prior to coming on-site so that time is saved when performing on-site calibration.

7.2.1 Calibrating a Personal Sampling Pump with an Electronic Calibrator

1. See Manufacturer's manual for operational instructions.

2. Set up the calibration train as shown in (Figure 3, Appendix B) using a sampling pump, electronic calibrator, and a representative filter cassette. The same lot sampling cassette used for sampling should also be used for calibrating.

3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 foot) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the electronic calibrator.

4. Turn the electronic calibrator and sampling pump on. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

5. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

6. Perform the calibration three times until the desired flow rate of ± 5% is attained.

7.2.2 Calibrating a Rotameter with an Electronic Calibrator

1. See manufacturer's manual for operational instructions.

2. Set up the calibration train as shown in (Figure 4, Appendix B) using a sampling pump, rotameter, and electronic calibrator.

3. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6° vertical.

4. Turn the electronic calibrator and sampling pump on.

5. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

6. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

7. Record the electronic calibrator flow rate reading and the corresponding rotameter reading. Indicate these values on the rotameter (sticker). The rotameter should be able to work within the desired flow range. Readings can also be calibrated for 10 cm^3 increments for Low Flow rotameters, 500 cm^3 increments for medium flow rotameters and 1 liter increments for high flow rotameters.

8. Perform the calibration three times until the desired flow rate of ± 5% is attained. Once on site, a secondary calibrator, i.e., rotameter may be used to calibrate sampling pumps.

7.2.3 Calibrating a Personal Sampling Pump with a Rotameter

1. See manufacturer's manual for Rotameter's Operational Instructions.

2. Set up the calibration train as shown in (Figure 5, Appendix B) using a rotameter, sampling pump, and a representative sampling cassette.

3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 ft) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the rotameter.

4. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6° vertical.

5. Turn the sampling pump on.

6. Turn the flow adjust screw (or knob) on the personal sampling pump until the float ball on the rotameter is lined up with the precalibrated flow rate value. A sticker on the rotameter should indicate this value.

7. A verification of calibration is generally performed on-site in the clean zone immediately prior to the sampling.

7.3. Meteorology

It is recommended that a meteorological station be established. If possible, sample after two to three days of dry weather and when the wind conditions are at 10 mph or greater. Record wind speed, wind direction, temperature, and pressure in a field logbook. Wind direction is particularly important when monitoring for asbestos downwind from a fixed source.

7.4 Ambient Sampling Procedures

7.4.1 Pre-site Sampling Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling equipment and ensure it is in working order and fully charged (if necessary).

3. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety plan.

4. Once on-site the calibration is performed in the clean zone. The calibration procedures are listed in Section 7.2.

5. After calibrating the sampling pump, mobilize to the sampling location.

7.4.2 Site Sampling

1. To set up the sampling train, attach the air intake hose to the cassette base. Remove the cassette cap (Figure 6 and 7, Appendix B). The cassette should be positioned downward, perpendicular to the wind

2. If AC or DC electricity is required then turn it on. If used, the generator should be placed 10 ft. downwind from the sampling pump.

3. Record the following in a field logbook: date, time, location, sample identification number, pump number, flow rate, and cumulative time.

4. Turn the pump on. Should intermittent sampling be required, sampling filters must be covered between active periods of sampling. To cover the sample filter: turn the cassette to face upward, place the cassette cap on the cassette, remove the inlet plug from the cassette cap, attach a rotameter to the inlet opening of the cassette cap to measure the flow rate, turn off the sampling pump, place the inlet plug into the inlet opening on the cassette cap. To resume sampling: remove the inlet plug, turn on the sampling pump, attach a rotameter to measure the flow rate, remove the cassette cap, replace the inlet plug in the cassette cap and invert the cassette, face downward and perpendicular to the wind.

5. Check the pump at sampling midpoint if sampling is longer than 4 hours. The generators may need to be regased depending on tank size. If a filter darkens in appearance or if loose dust is seen in the filter, a second sample should be started.

6. At the end of the sampling period, orient the cassette up, turn the pump off.

7. Check the flow rate as shown in Section 7.2.3. When sampling open-faced, the sampling cap should be replaced before post calibrating. Use the same cassette used for sampling for post calibration (increase dust/fiber loading may have altered the flow rate.

8. Record the post flow rate.

9. Record the cumulative time or run.

10. Remove the tubing from the sampling cassette. Still holding the cassette upright, replace the inlet plug on the cassette cap and the outlet plug on the cassette base.

7.4.3. Post Site Sampling

1. Follow handling procedures in Section 3.2, steps 1-4.

2. Obtain an electronic or hard copy of meteorological data which occurred during the sampling event. Record weather: wind speed, ambient temperature, wind direction, and precipitation. Obtaining weather data several days prior to the sampling event can also be useful.

7.5 Indoor Sampling Procedures

PCM analysis is used for indoor air samples. When analysis shows total fiber count above the OSHA action level 0.1 f/cc then TEM (U.S. EPA's Modified Yamate Method) is used to identify asbestos from non-asbestos fibers.

Sampling pumps should be placed four to five feet above ground level away from obstructions that may influence air flow. The pump can be placed on a table or counter. Refer to Table 2 (Appendix A) for a summary of indoor sampling locations and rationale for selection.

Indoor sampling utilizes high flow rates to increased sample volumes (2000 L for PCM and 2800 to 4200 L for TEM) in order to obtain lower detection limits below the standard, (i.e., 0.01 f/cc or lower [PCM] and 0.005 structures/cc or lower [TEM]).

7.5.1 Aggressive Sampling Procedures

Sampling equipment at fixed locations may fail to detect the presence of asbestos fibers. Due to limited air movement, many fibers may settle out of the air onto the floor and other surfaces and may not be captured on the filter. In the past, an 8-hour sampling period was recommended to cover various air circulation conditions. A quicker and more effective way to capture asbestos fibers is to circulate the air artificially so that the fibers remain airborne during sampling. The results from this sampling option typifies worst case condition. This is referred to as aggressive air sampling for asbestos. Refer to Table 2 for sample station locations.

1. Before starting the sampling pumps, direct forced air (such as a 1-horsepower leaf blower or large fan) against walls, ceilings, floors, ledges, and other surfaces in the room to initially dislodge fibers from surfaces. This should take at least 5 minutes per 1000 sq. ft. of floor.

2. Place a 20-inch fan in the center of the room. (Use one fan per 10,000 cubic feet of room space.) Place the fan on slow speed and point it toward the ceiling.

3. Follow procedures in Section 7.4.1 and 7.4.2 (Turn off the pump and then the fan(s) when sampling is complete.).

4. Follow handling procedures in Section 3.2, steps 1-4.

8.0 CALCULATIONS

The sample volume is calculated from the average flow rate of the pump multiplied by the number of minutes the pump was running (volume = flow rate X time in minutes). The sample volume should be submitted to the laboratory and identified on the chain of custody for each sample (zero for lot, field and trip blanks).

The concentration result is calculated using the sample volume and the numbers of asbestos structures reported after the application of the cluster and matrix counting criteria.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Follow all QA/QC requirements from the laboratories as well as the analytical methods.

9.1 TEM Requirements

1. Examine lot blanks to determine the background asbestos structure concentration.

2. Examine field blanks to determine whether there is contamination by extraneous asbestos structures during specimen preparation.

3. Examine of laboratory blanks to determine if contamination is being introduced during critical phases of the laboratory program.

4. To determine if the laboratory can satisfactorily analyze samples of known asbestos structure concentrations, reference filters shall be examined. Reference filters should be maintained as part of the laboratory's Quality Assurance program.

5. To minimize subjective effects, some specimens should be recounted by a different microscopist.

6. Asbestos laboratories shall be accredited by the National Voluntary Laboratory Accreditation Program.

7. At this time, performance evaluation samples for asbestos in air are not available for Removal Program Activities.

9.2 PCM Requirements

1. Examine reference slides of known concentration to determine the analyst's ability to satisfactorily count fibers. Reference slides should be maintained as part of the laboratory's quality assurance program.

2. Examine field blanks to determine if there is contamination by extraneous structures during sample handling.

3. Some samples should be relabeled then submitted for counting by the same analyst to determine possible bias by the analyst.

4. Participation in a proficiency testing program such as the AIHA-NIOSH proficiency analytical testing (PAT) program.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures. More specifically, when entering an unknown situation involving asbestos, a powered air purifying respirator (PAPR) (full face-piece) is necessary in conjunction with HEPA filter cartridges. See applicable regulations for action level, PEL, TLV, etc. If previous sampling indicates asbestos concentrations are below personal health and safety levels, then Level D personal protection is adequate.

12.0 REFERENCES

(1) Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air, Part 1: Method, EPA/540/2-90/005a, May 1990, and Part 2: Technical Background Document, EPA/540/2-90/005b, May 1990.

(2) Methodology for the Measurement of Airborne Asbestos by Electron Microscopy, EPA's Report No. 68-02-3266, 1984, G. Yamate, S.C. Agarwal, and R. D. Gibbons.

(3) National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Method. Third Edition. 1987.

(4) U.S. Environmental Protection Agency. Code of Federal Regulations 40 CFR 763. July 1, 1987. Code of Federal Regulations 40 CFR 763 Addendum. October 30, 1987.

(5) U.S. Environmental Protection Agency. Asbestos-Containing Materials in Schools; Final Rule and Notice. 52 FR 41826.

(6) Occupational Safety and Health Administration. Code of Federal Regulations 29 CFR 1910.1001. Washington, D.C. 1987.

APPENDIX A

Tables

TABLE 1. SAMPLE STATIONS FOR OUTDOOR SAMPLING		
Sample Station Location	Sample Numbers	Rationale
Upwind/Background[1]	Collect a minimum of two simultaneous upwind/background samples 30° apart from the prevailing windlines.	Establishes background fiber levels.
Downwind	Deploy a minimum of 3 sampling stations in a 180 degree arc downwind from the source.	Indicates if asbestos is leaving the site.
Site Representative and/or Worst Case	Obtain one site representative sample which shows average condition on-site or obtain worst case sample (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

[1] More than one background station may be required if the asbestos originates from different sources.

APPENDIX A (Cont'd)

Tables

TABLE 2

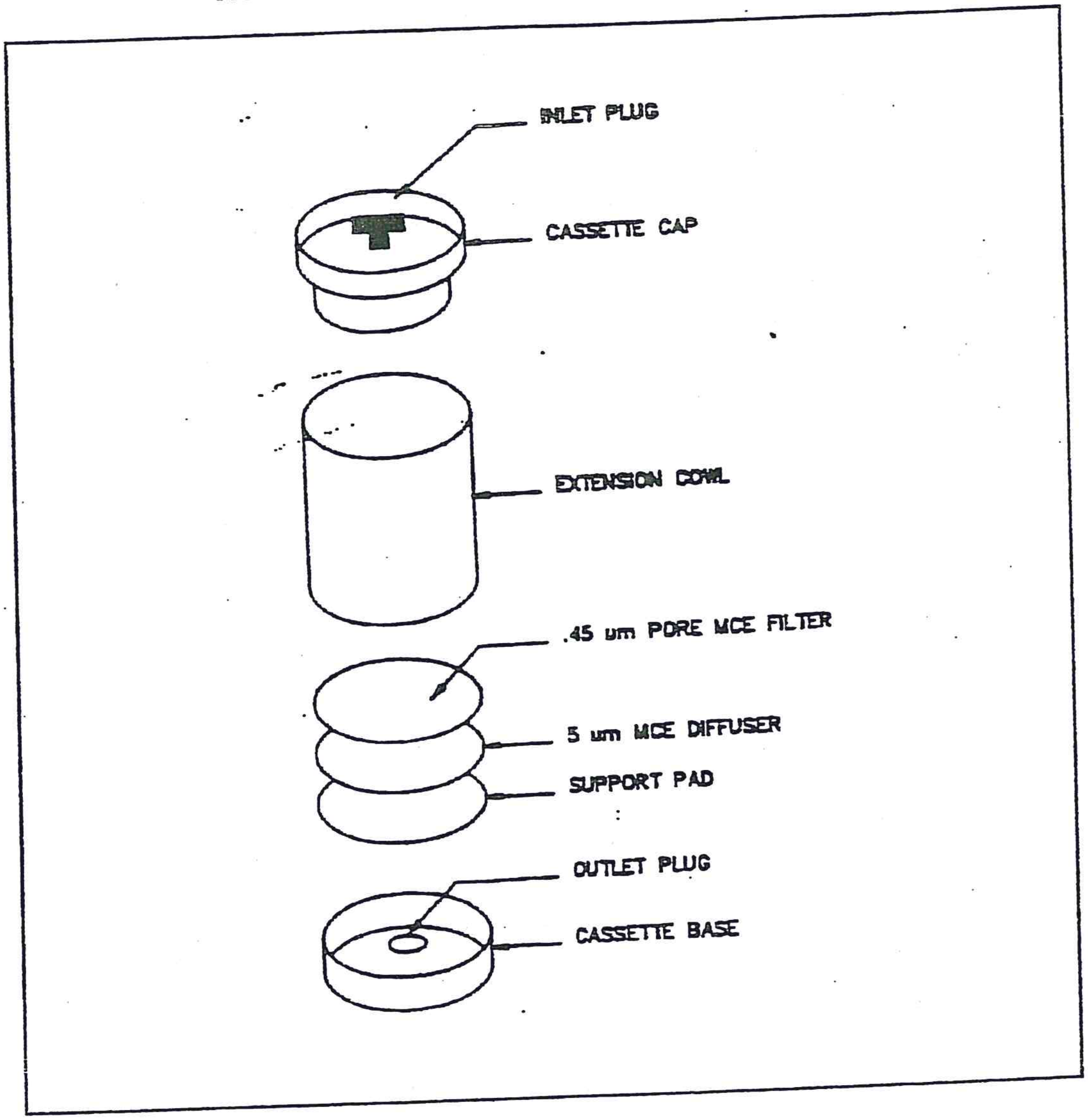
SAMPLE STATIONS FOR INDOOR SAMPLING

Sample Station Location	Sample Numbers	Rationale
Indoor Sampling	If a work site is a single room, disperse 5 samplers throughout the room. If the work site contains up to 5 rooms, place at least one sampler in each room. If the work site contains more than 5 rooms, select a representative sample of the rooms.	Establishes representative samples from a homogeneous area.
Upwind/Background	If outside sources are suspected, deploy a minimum of two simultaneous upwind/background samples 30° apart from the prevailing windlines.	Establish whether indoor asbestos concentrations are coming from an outside source.
Worst Case	Obtain one worst case sample, i.e., aggressive sampling (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

APPENDIX B

Figures

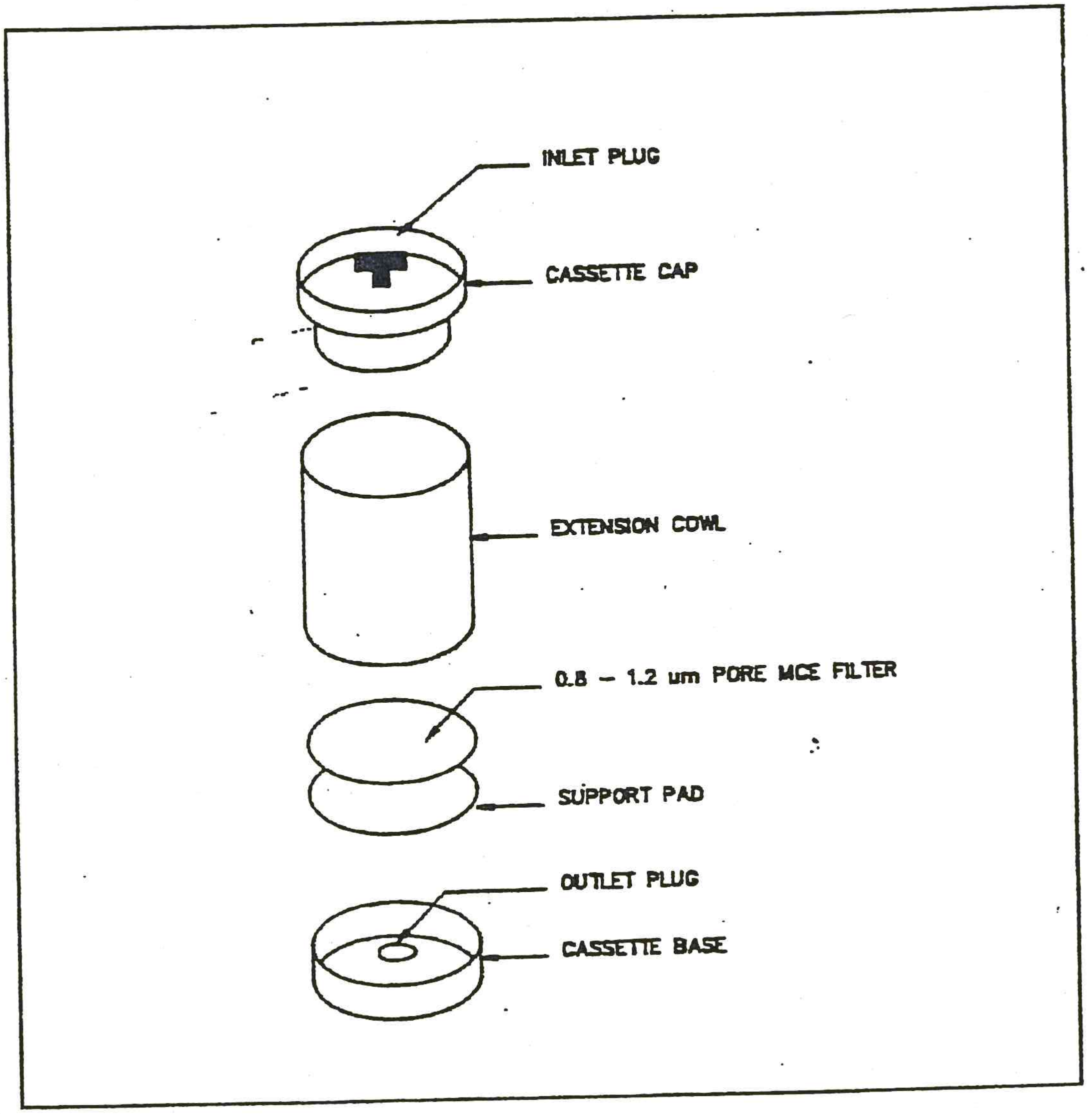
FIGURE 1. Transmission Electron Microscopy Filter Cassette



APPENDIX B (Cont'd)

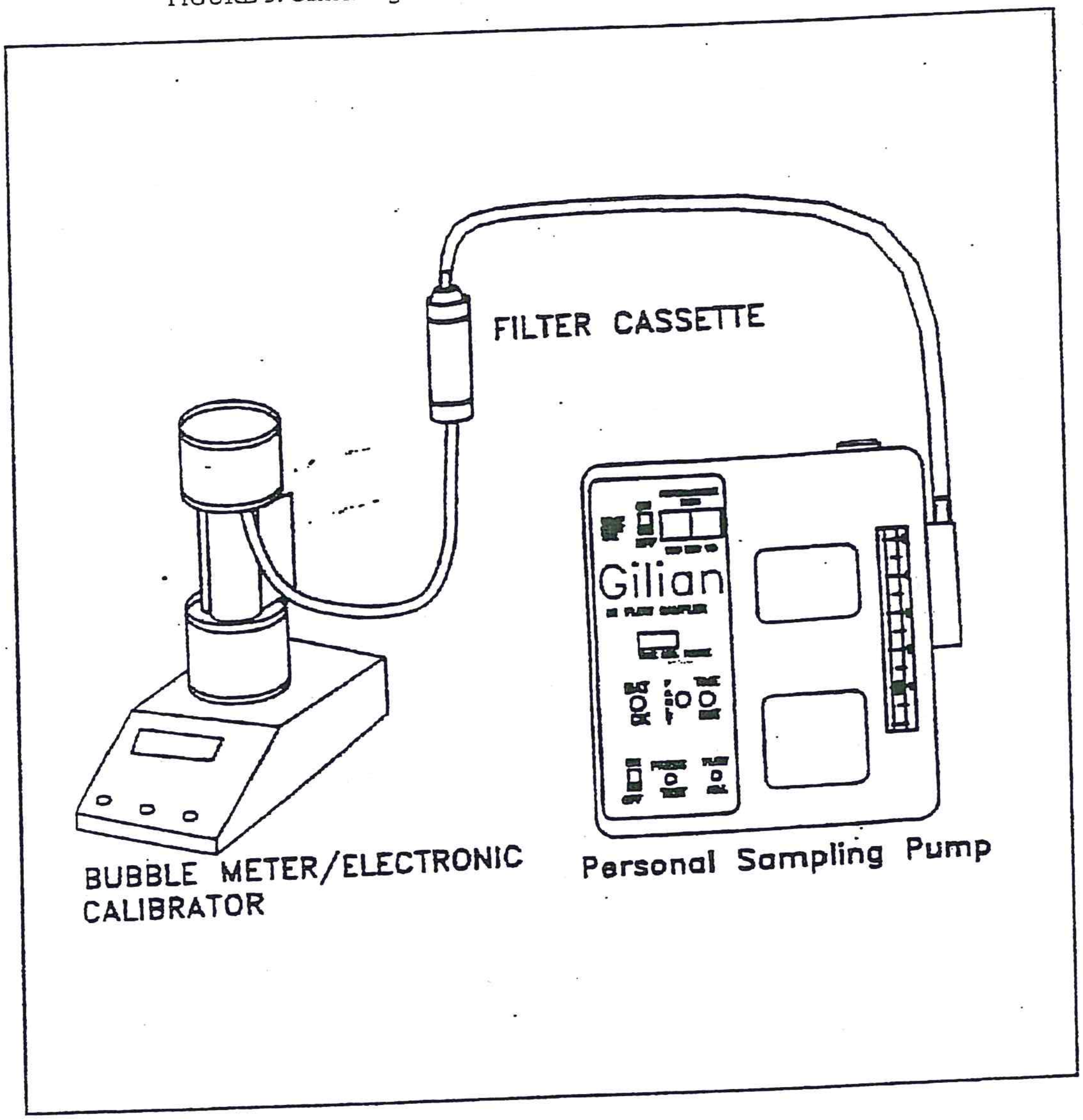
Figures

FIGURE 2. Phase Contrast Microscopy Filter Cassette



Figures

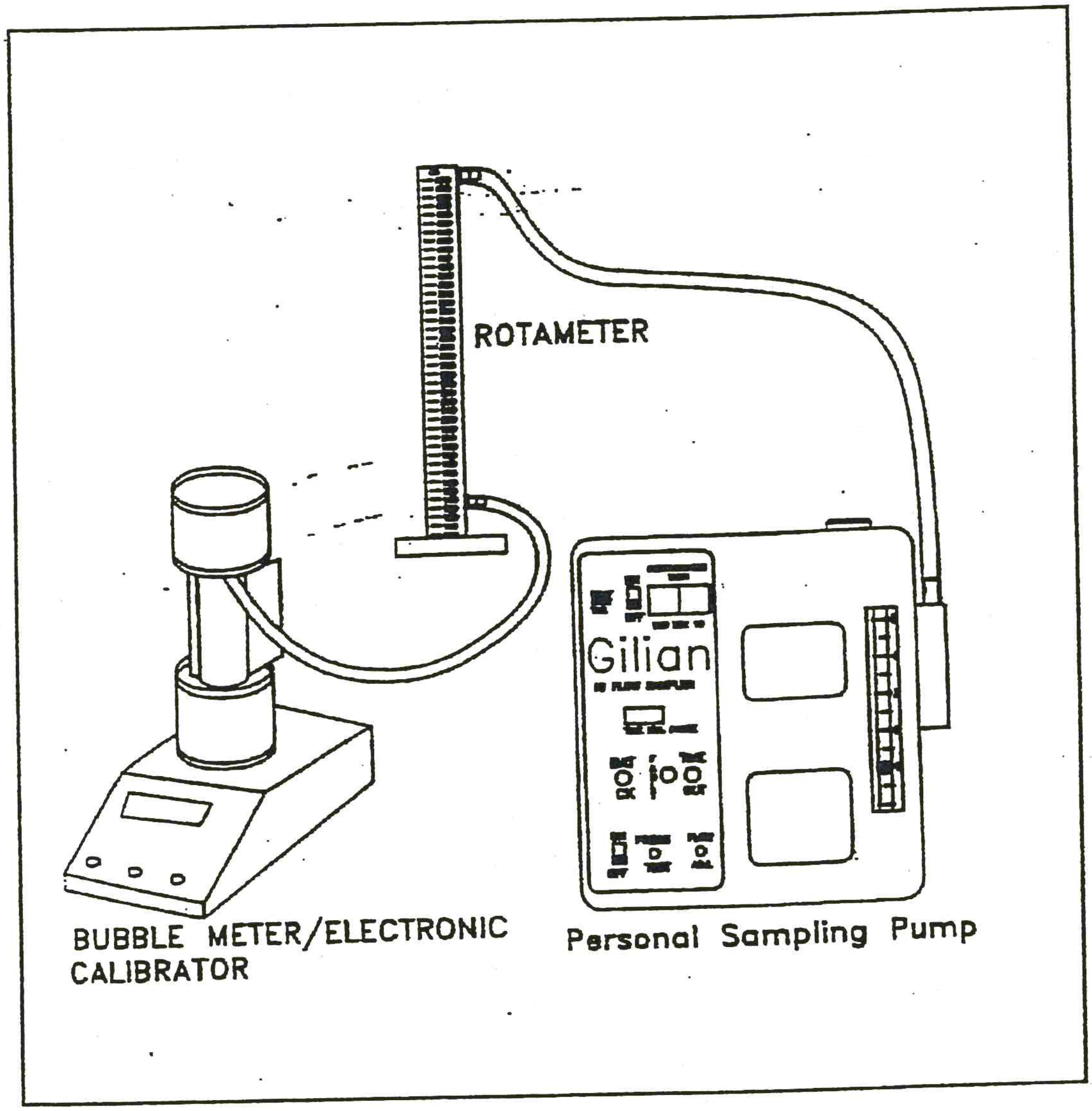
FIGURE 3. Calibrating a Personal Sampling Pump with a Bubble Meter



APPENDIX B (Cont'd)

Figures

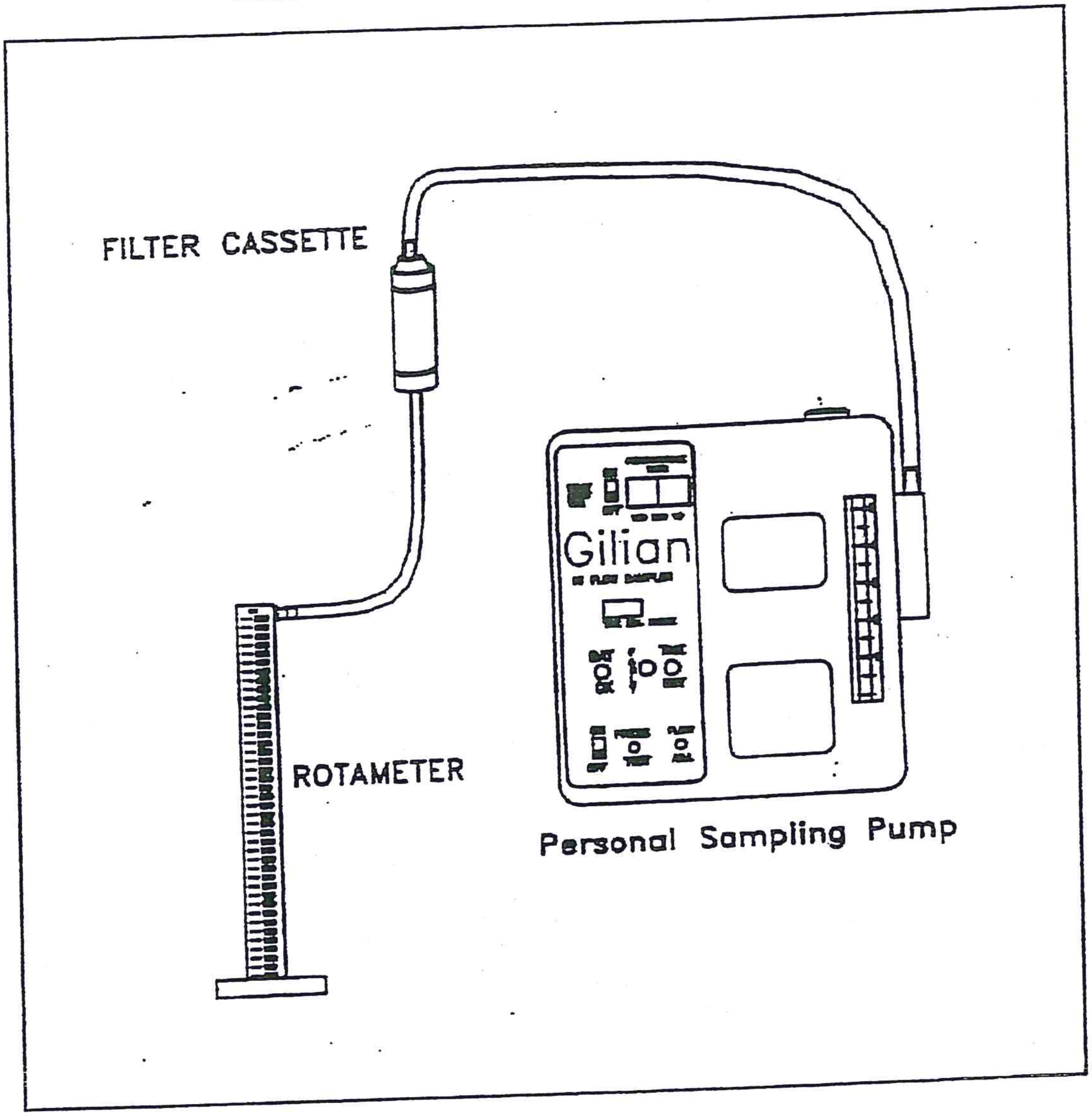
FIGURE 4. Calibrating a Rotameter with a Bubble Meter



APPENDIX B (Cont'd)

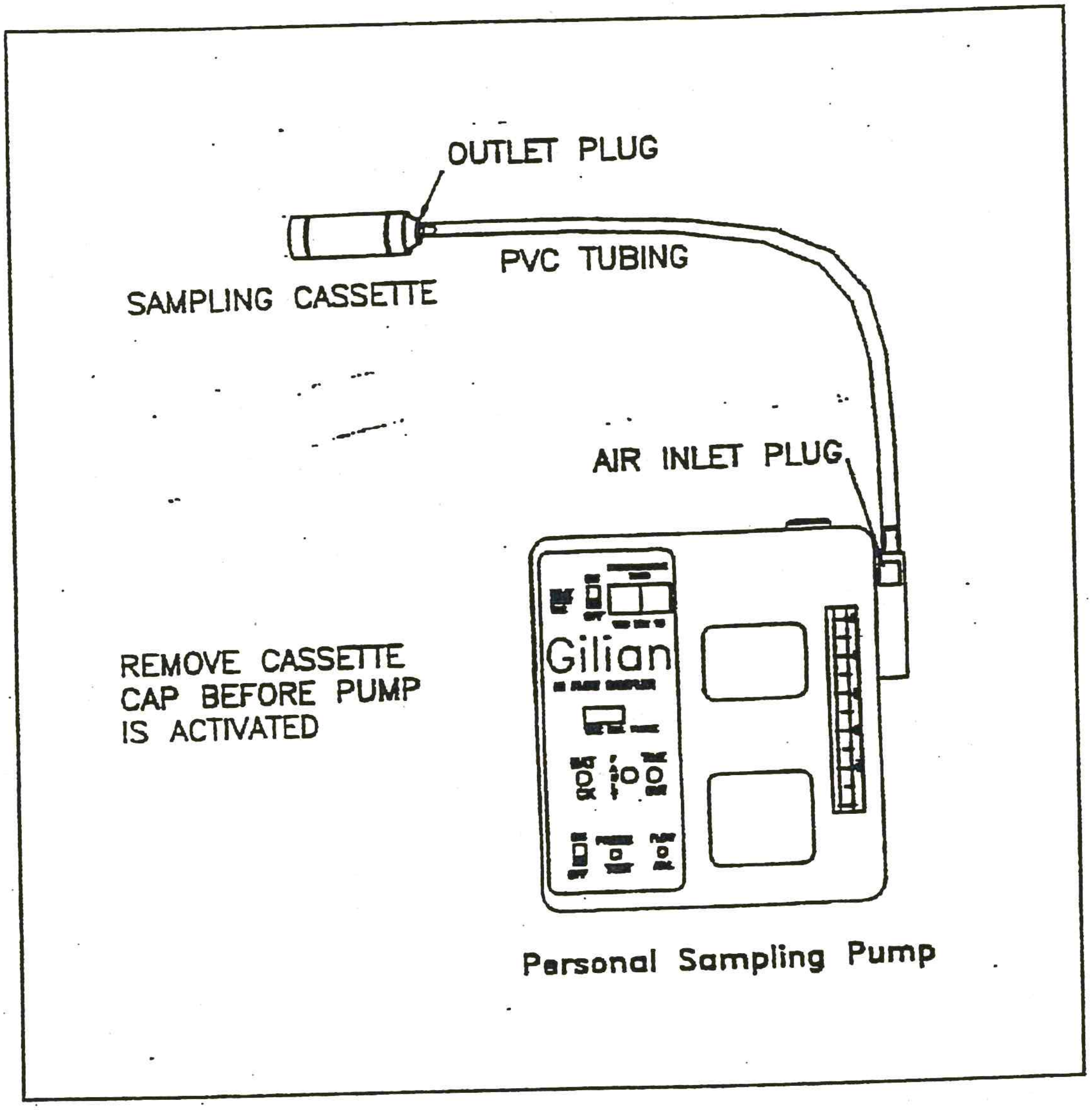
Figures

FIGURE 5. Calibrating a Sampling Pump with a Rotameter



Figures

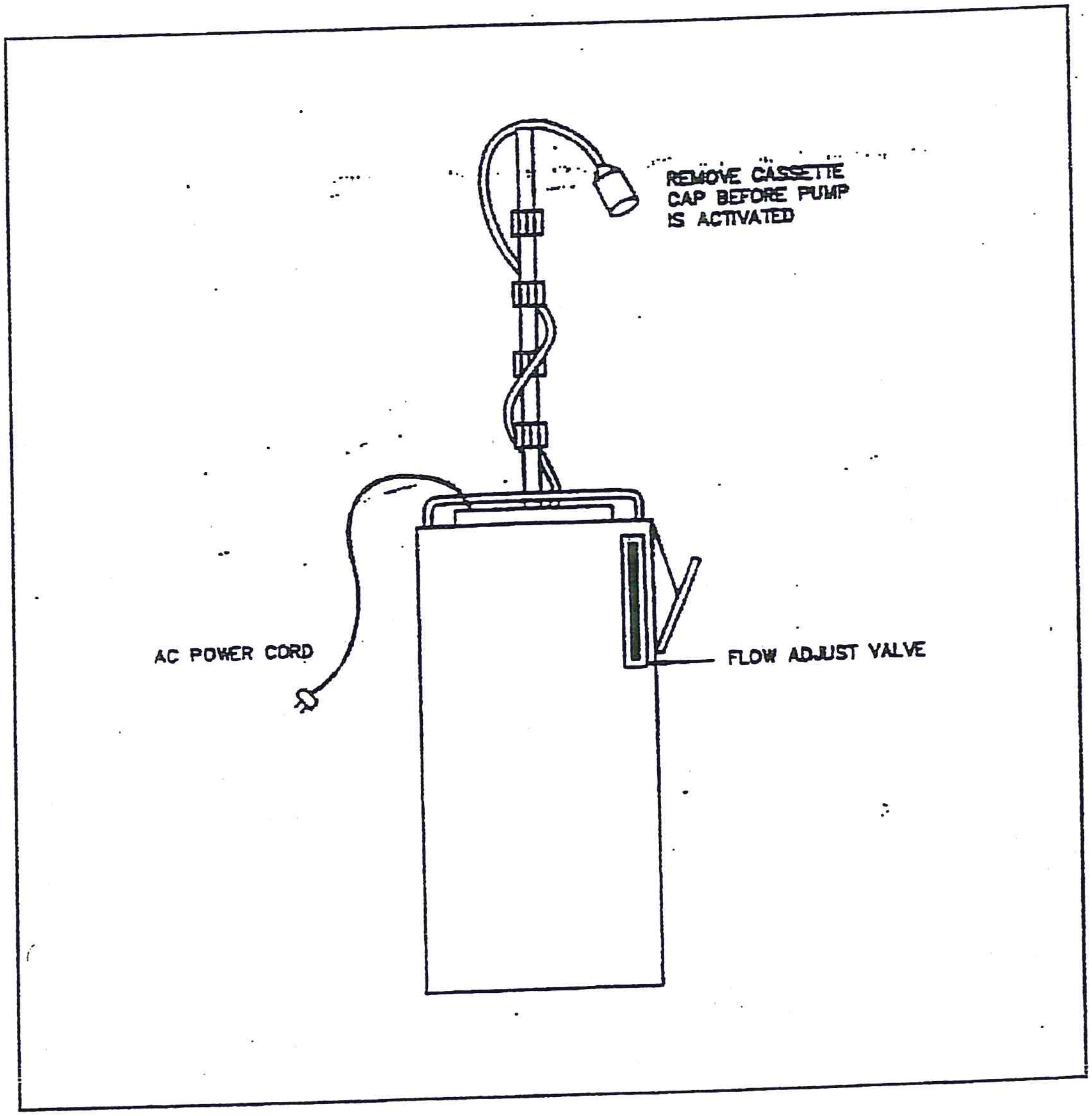
FIGURE 6. Personal Sampling Train for Asbestos



APPENDIX B (Cont'd)

Figures

FIGURE 7. High Flow Sampling Train for Asbestos



Project Specific Modification

SOP No.: 2-2

SOP Title: Guide to Handling Investigation-Derived Waste

Project: Libby Asbestos Remedial Investigation (RI)

Project No.: 3282-137

Client: U.S. Environmental Protection Agency

Project Manager: [signature] Date: 5/7/03

Technical Reviewer: [signature] Date: 5/7/03

QA Reviewer: [signature] Date: 5/12/03

EPA Approval: [signature] Date: 5/19/03

Reason for and duration of modification: Site-specific procedures for disposing of Libby amphibole asbestos contaminated IDW are different than CDM Technical SOP 2-2. These modifications are necessary for the entire duration of the project.

All IDW will be handled in accordance with CDM Technical SOP 2-2, Guide to Handling Investigation-Derived Waste, with the following modifications:

Section 5.2. Off Site Disposal - All IDW (not including excess soil volume) will be collected in transparent garbage bags and marked "IDW" with an indelible marker. These bags will be deposited into the asbestos contaminated waste stream for deposal at the mine.

Lincoln County Class IV Asbestos Landfill Cell Operations Plan

Work Process Review Form

Contractor ______________________ Date ______________________

Reason for Work Process Review

Project Location ______________________

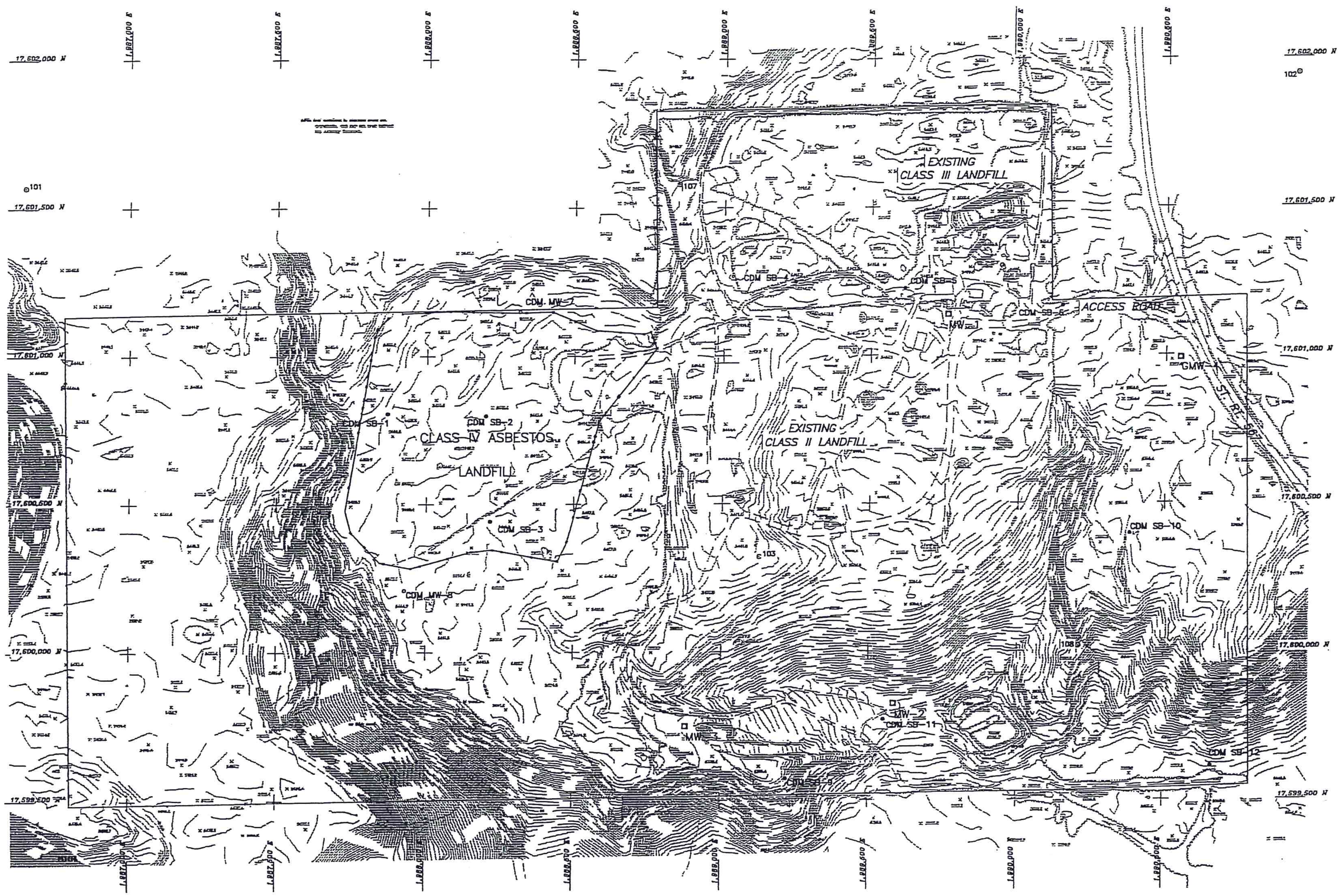
Personnel Present

Identified Hazards (attach additional sheets if necessary)

Recommended Corrective Actions (attach additional sheets if necessary)

Contractor Project Manager

Date: ______________________



1" =400'

100 0 200

LEGEND

EXISTING INDEX CONTOUR
EXISTING INTERMEDIATE CONTOUR
CLEARING LINE
PROPERTY LINE
EXISTING GRAVEL ROAD
CONTROL POINT ⊕102
SPOT ELEVATION x 2422.1
MONITORING WELL ○
SOIL BORING •
EXISTING WELL □

N

NOTES:

1. SURVEY CONTROL POINTS

POINT	NORTH	EAST	ELEVATION
101	17601570.659	1986651.068	2446.93
102	17601947.022	1990942.823	2431.60
103	17600321.115	1989127.522	2408.36
104	17599313.644	1986781.024	2396.92
105	17598957.650	1990846.624	2292.54
107	17601579.957	1988850.633	2433.09
108	17600017.949	1990212.028	2360.76

2. SURVEY CONTROL PROVIDED BY JRS SURVEYING
DICK STAPLES
6476 MAIN
BONNERS FERRY IDAHO
1-208-267-7555
3. MAPPING PROVIDED BY HORIZONS INC.
3600 JET DRIVE
P.O. BOX 3134
RAPID CITY, SD 57709-3134
1-605-343-0280
4. THE ADJACENT PROPERTY IS OWNED ENTIRELY BY THE UNITED STATES FOREST SERVICE.
5. CALL U-DIG 1-800-551-8344 48 HOURS PRIOR TO ALL EXCAVATION FOR UTILITY LOCATION/RELOCATION.
6. THE EXISTING WELLS LOCATIONS AS SHOWN ARE APPROXIMATE.

MONITORING WELL AND SOIL BORING COORDINATES

NORTHING	EASTING	ELEV.	DESC.
17599612.0741	1990666.4149	2297.25	SB-12
17600396.4306	1990381.2376	2384.78	SB-10
17601167.2690	1990147.6783	2403.17	SB-6
17601225.4667	1989619.4604	2410.82	SB-5
17601249.9556	1989244.5539	2412.24	SB-4
17600441.9745	1988218.7977	2408.80	SB-3
17600798.5419	1988202.0921	2413.45	SB-2
17600209.1433	1987927.5318	2414.42	MW-8
17600806.6185	1987868.0285	2417.12	SB-1
17601150.6797	1988317.2429	2421.76	MW-7
17599572.8763	1989224.8457	2377.13	SPIKE/SB-9
17599771.1465	1989554.7753	2318.39	SB-11

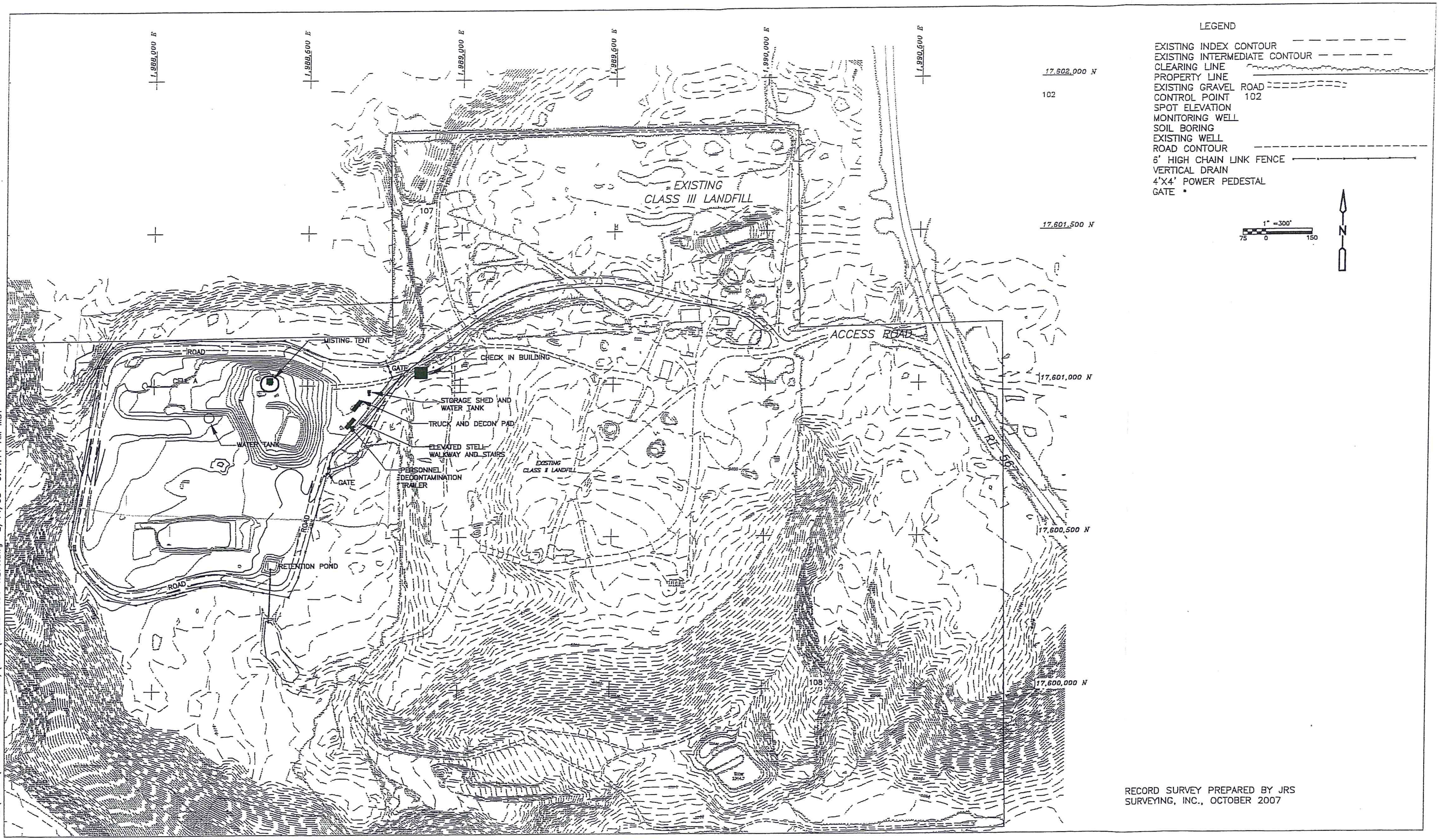
NOTES:
1. THE PROTECTIVE STEEL CASING ELEVATIONS ARE 0.24' HIGHER THAN THE TOP OF THE PVC CASING ELEVATIONS OF THE MONITORING WELLS.

2. ELEVATIONS OF THE MONITORING WELLS IN ABOVE TABLE WERE MEASURED FROM THE TOP OF THE PVC CASINGS.

K:\34369(Libby Final OP)\dwg\36340-FIG4.dwg 02/14/2008 09:32:33 AM MST

Figure No. 4

SOIL BORING AND MONITORING WELL LOCATIONS



K:\41874(LIBBY LNF OPS PLAN)\DWG\34369-FIG1-REV1.dwg 2/14/08 9:04:11 AM MST

Figure No. 1